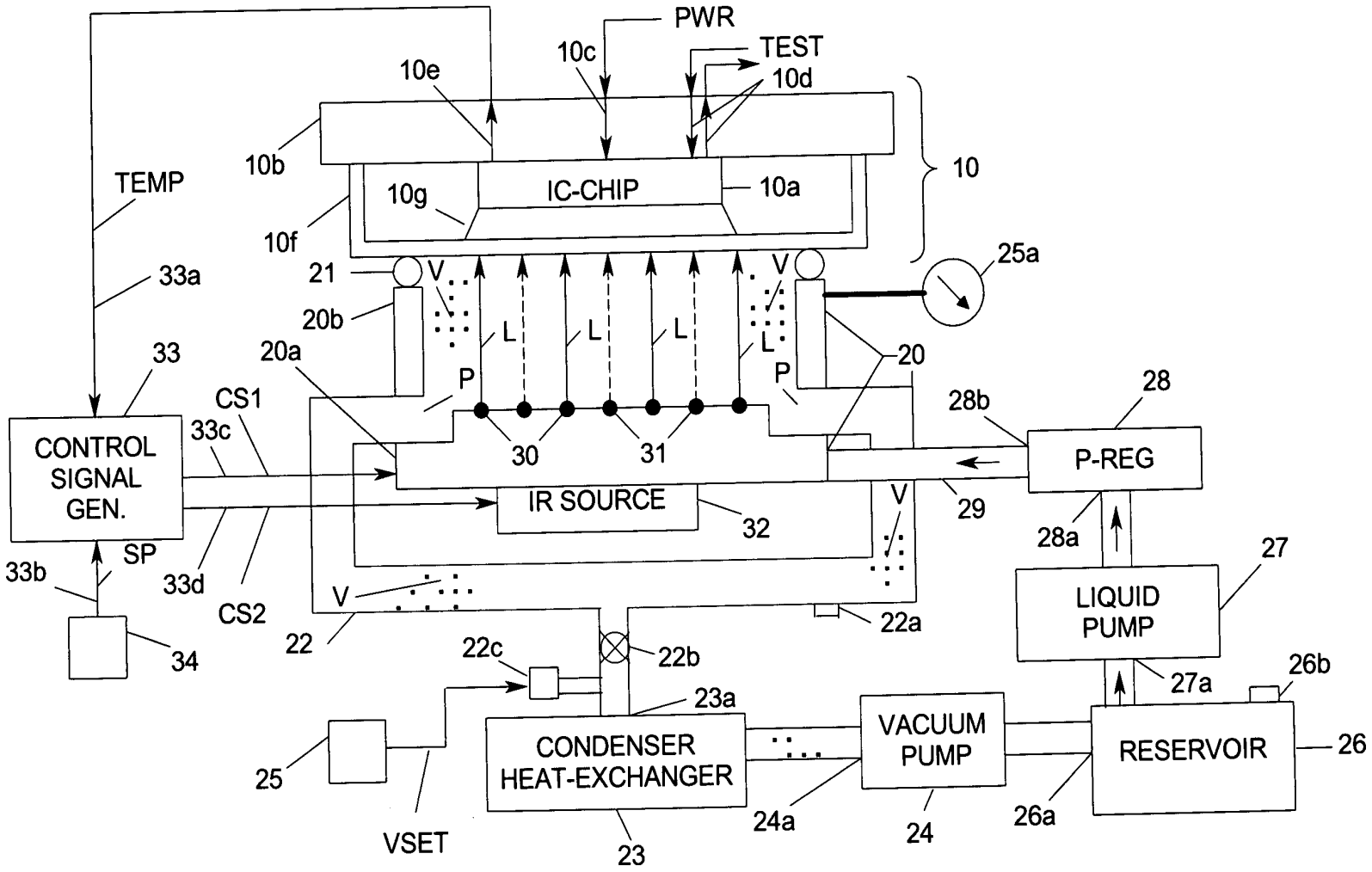

PWR
TEST
10c
10d
10e
10b
10
TEMP
10g
IC-CHIP
10a
10f
21
V
25a
33a
20b
L
20a
33
P
20
CS1
28b
28
33c
CONTROL SIGNAL GEN.
30
31
P-REG
IR SOURCE
32
29
28a
SP
33b
33d
CS2
27
LIQUID PUMP
22a
22
22c
22b
26b
27a
34
23a
25
CONDENSER HEAT-EXCHANGER
VACUUM PUMP
RESERVOIR
26
24a
26a
VSET
23
24

FIG. 1

FIG. 2

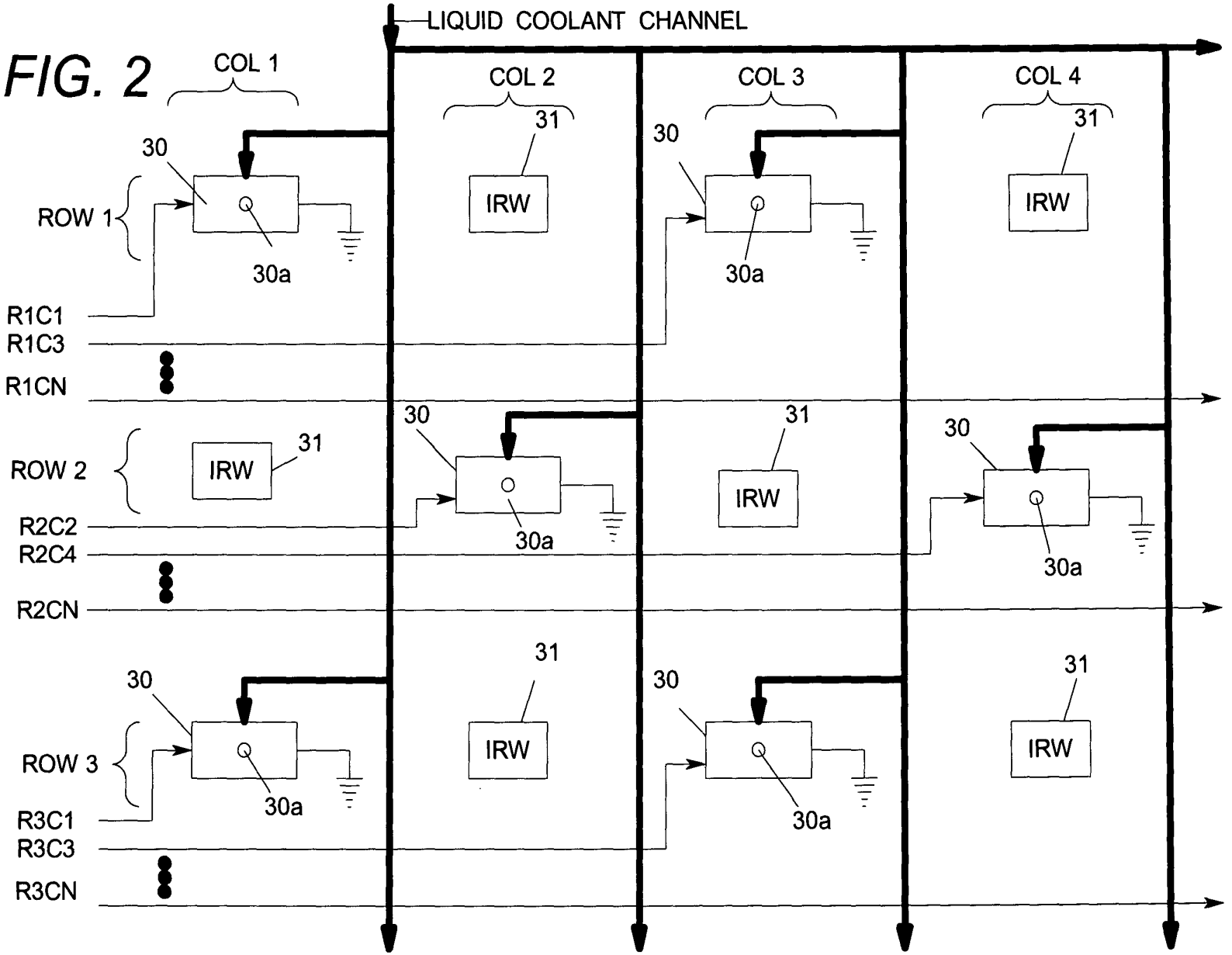
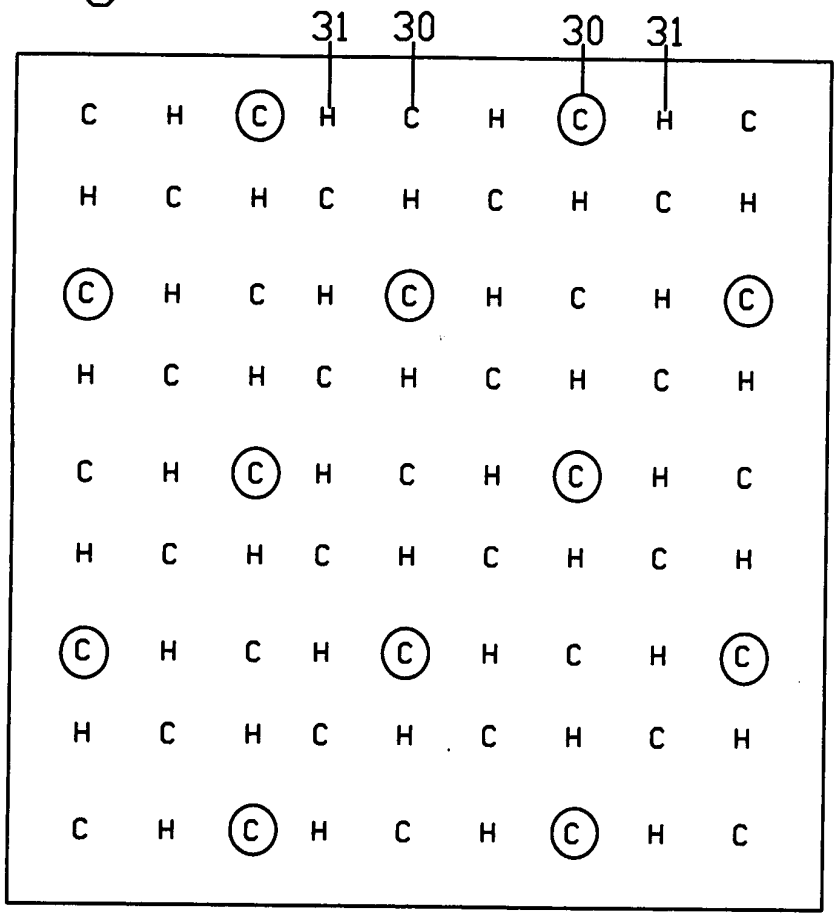
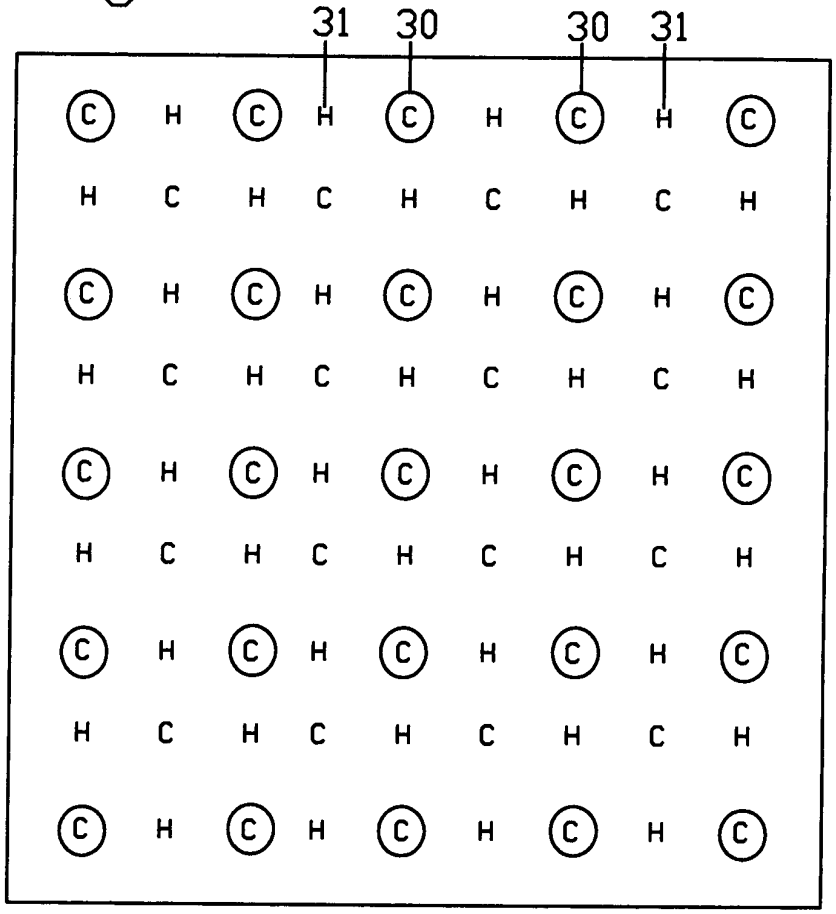

LIQUID COOLANT CHANNEL
COL 1
COL 2
COL 3
COL 4
ROW 1
ROW 2
ROW 3
30
30a
31
IRW
R1C1
R1C3
R1CN
R2C2
R2C4
R2CN
R3C1
R3C3
R3CN

Fig 3A



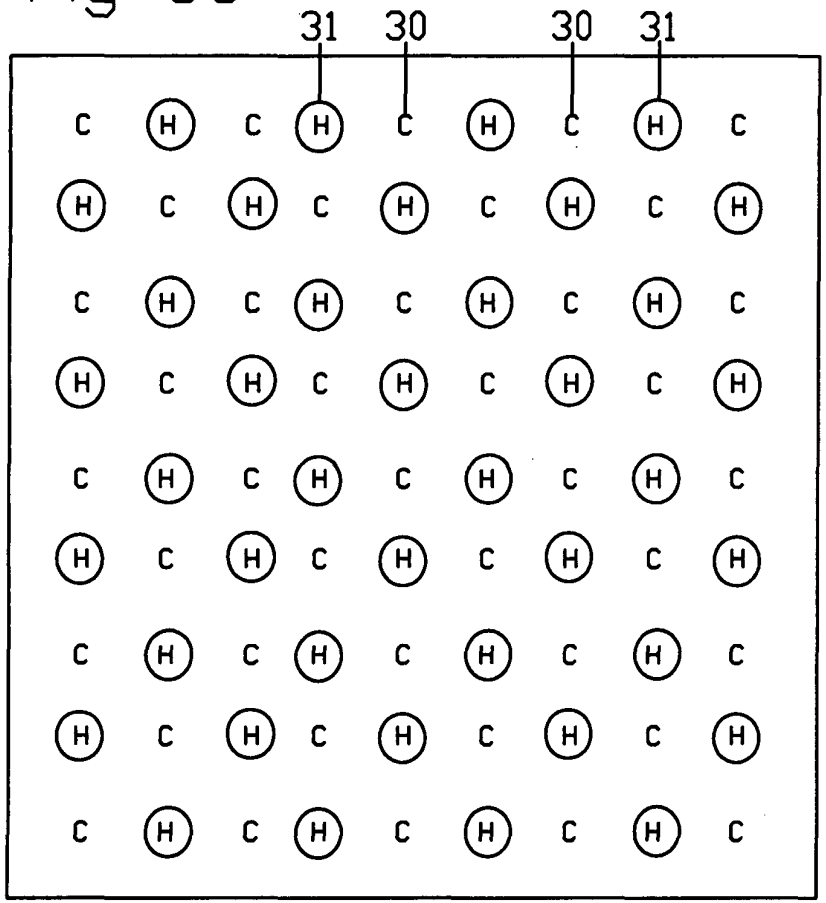
Chip power = 100W
Chip Temp = Tc

Fig 3B



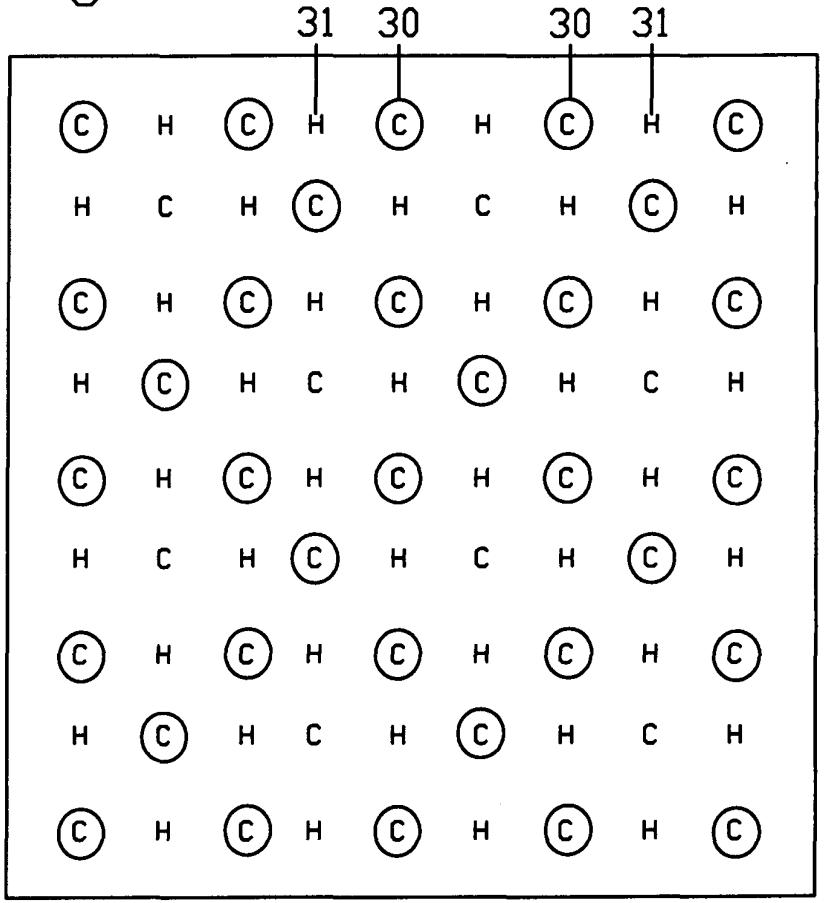
Chip Power = 200W
Chip Temp stays at Tc

Fig 3C



Chip Power = 0W
Chip Temp stays at Tc

Fig 3D



Chip Power = 300W
Chip Temp stays at Tc

FIG. 4

eq. 1 ~ $1\ drop = 10\ picoliter = 10*10^{-12}\ lit\ \frac{10^{3}\ gr}{lit} = 10^{-8}\ gr$

eq. 2 ~ $\Delta Q/drop = \left[\ (\Delta T)(c_p) + 2260\frac{J}{gr}\ \right]\frac{10^{-8}\ gr}{drop} \approx 20\frac{\mu J}{drop}$

eq. 3 ~ $400\ \frac{J}{sec} = 20\frac{\mu\ J}{drop}\ \left[\begin{matrix}\#of\\ nozzles\end{matrix}\right]\left[\begin{matrix}control\\ signal\ freq\end{matrix}\right]$

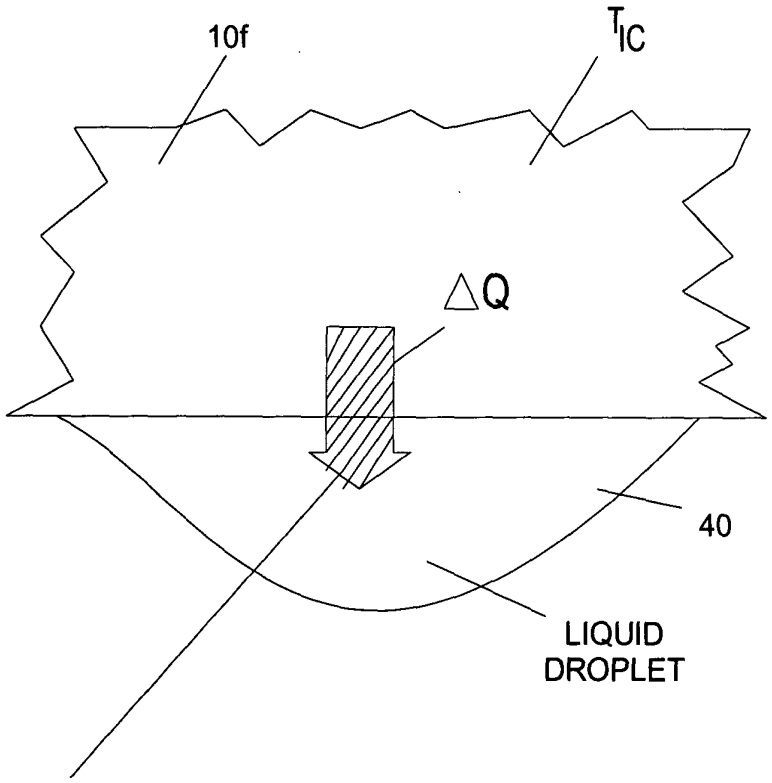
eq. 4 ~ $if\ freq = 10^{4}\ cycles/sec,\ then\ \left[\begin{matrix}\#of\\ nozzles\end{matrix}\right] = 2000$

eq. 5 ~ *nozzle array = (45) x (45) nozzles on 1 square inch*

eq. 6 ~ $nozzle\ spacing = \frac{2.54cm}{45\ nozzles} = \frac{560\mu m}{nozzle}$

eq. 7 ~ *area per nozzle = 50μm x 100μm*
area per IR-window = 20 μm x 20μm

FIG. 5A



$$\frac{\triangle Q}{\triangle t} \propto \left(T_{IC} - T_V \right)$$

FIG. 5B

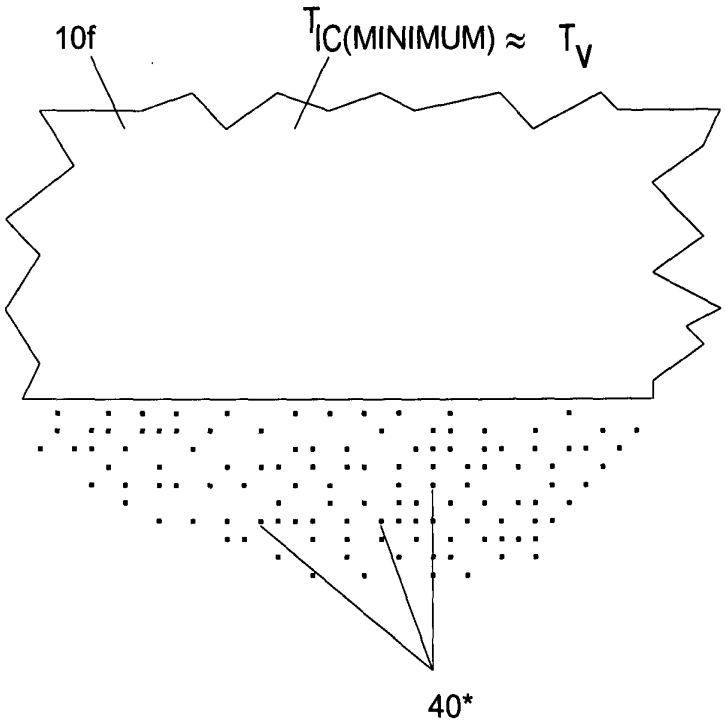


FIG. 6

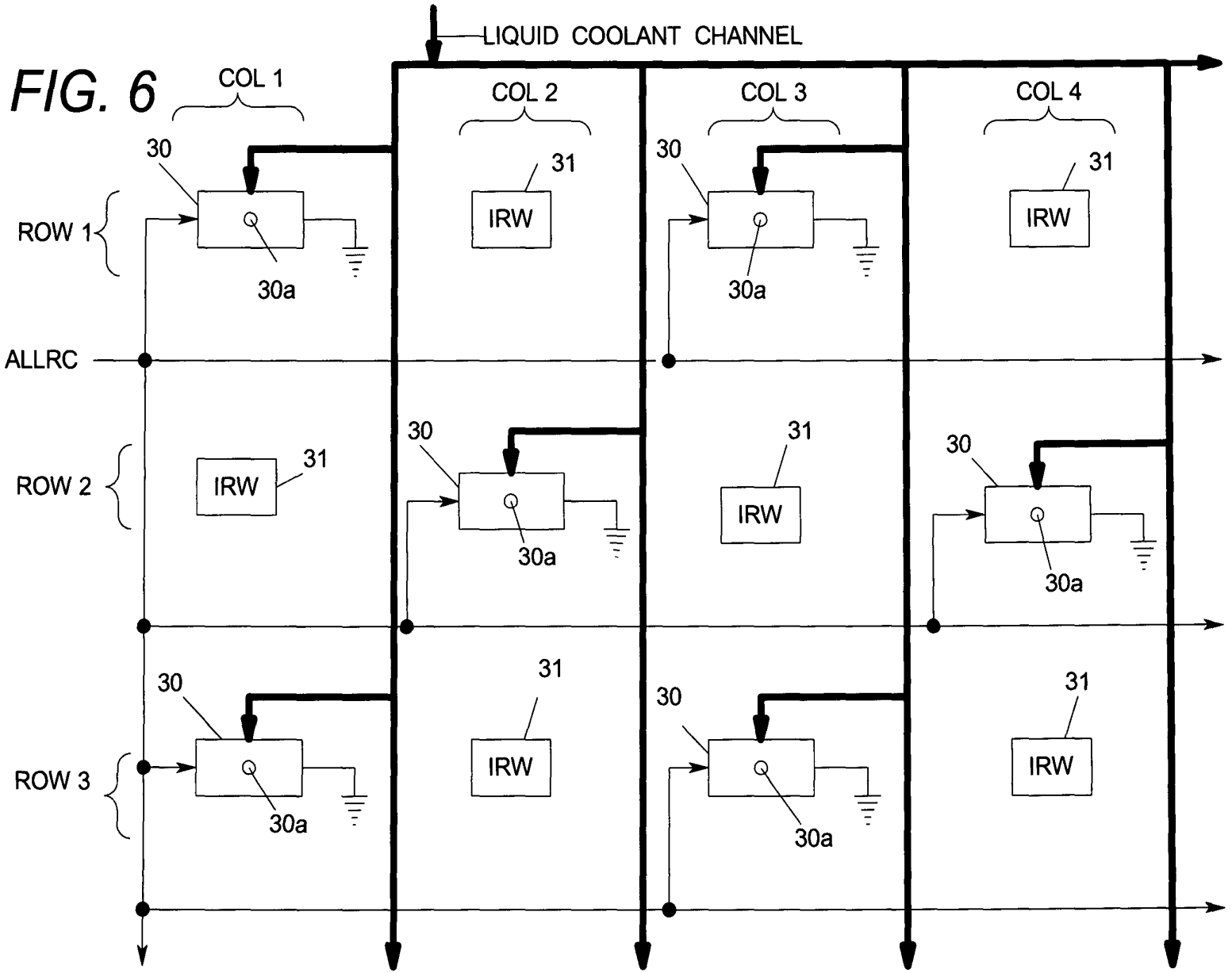

LIQUID COOLANT CHANNEL
COL 1
COL 2
COL 3
COL 4
ROW 1
ROW 2
ROW 3
ALLRC
30
30a
31
IRW

FIG. 7A

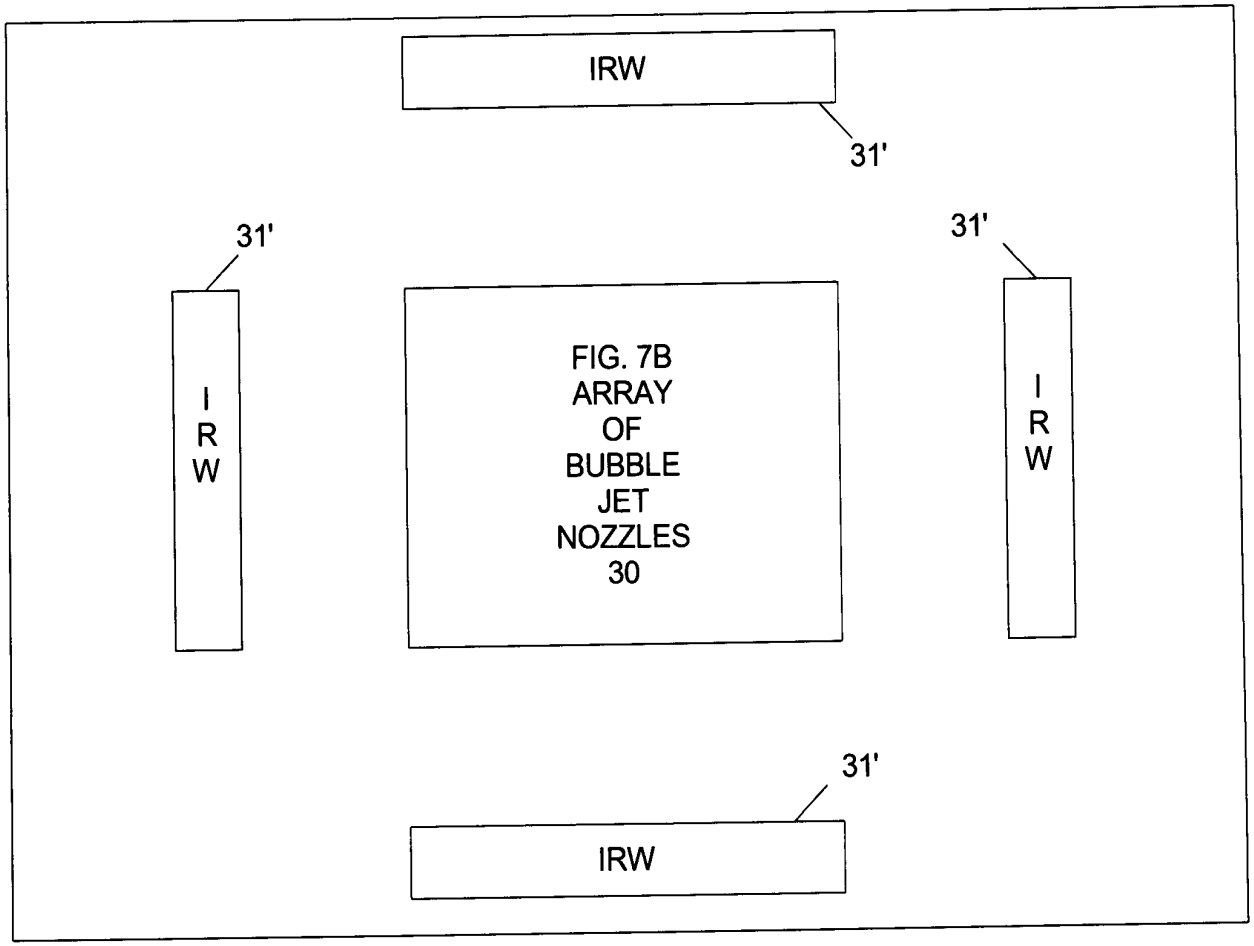

IRW
31'
31'
31'
I
R
W
FIG. 7B
ARRAY
OF
BUBBLE
JET
NOZZLES
30
I
R
W
31'
IRW

FIG. 7B

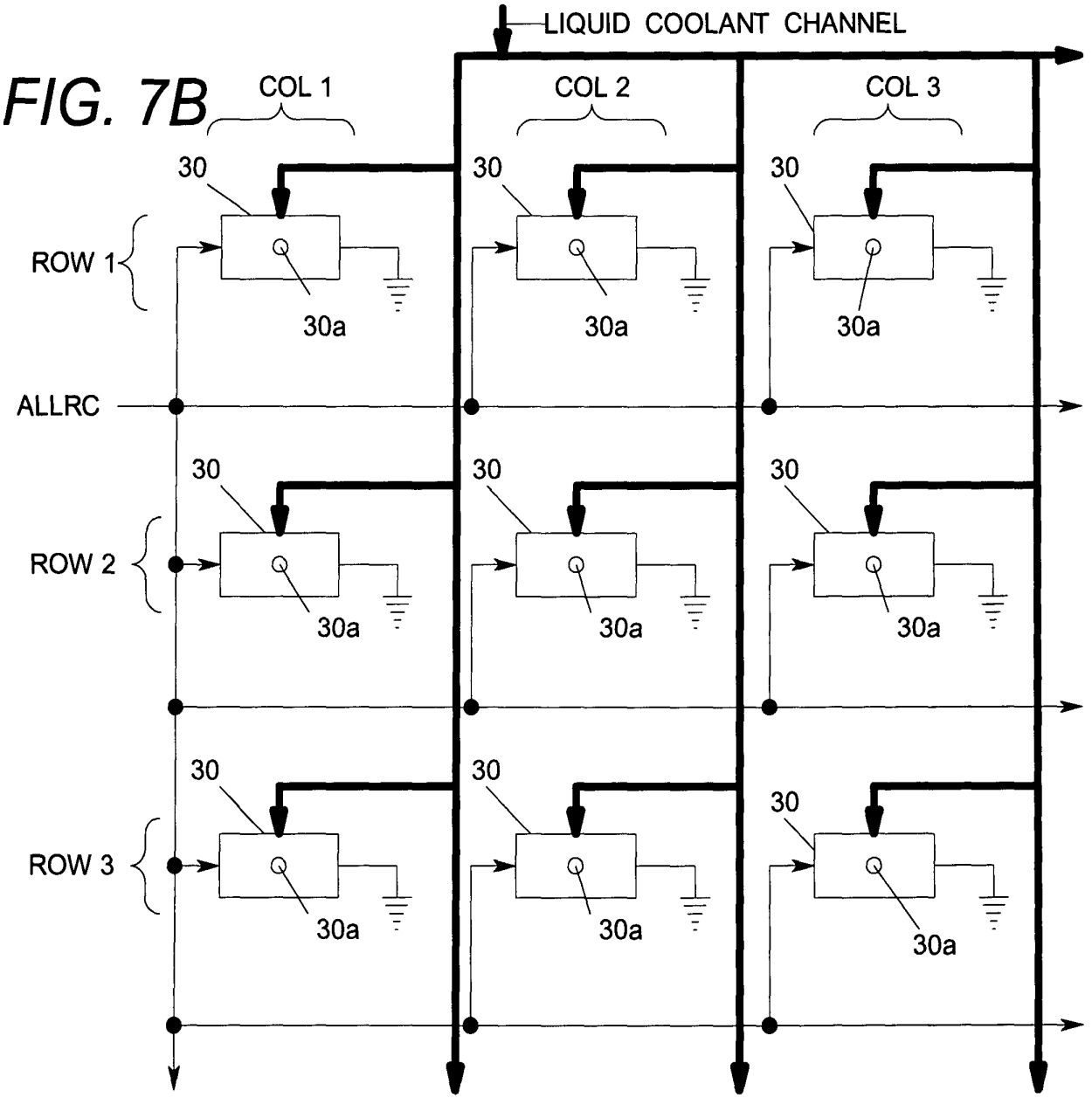

LIQUID COOLANT CHANNEL
COL 1
COL 2
COL 3
ROW 1
ROW 2
ROW 3
ALLRC
30
30a

FIG. 7C

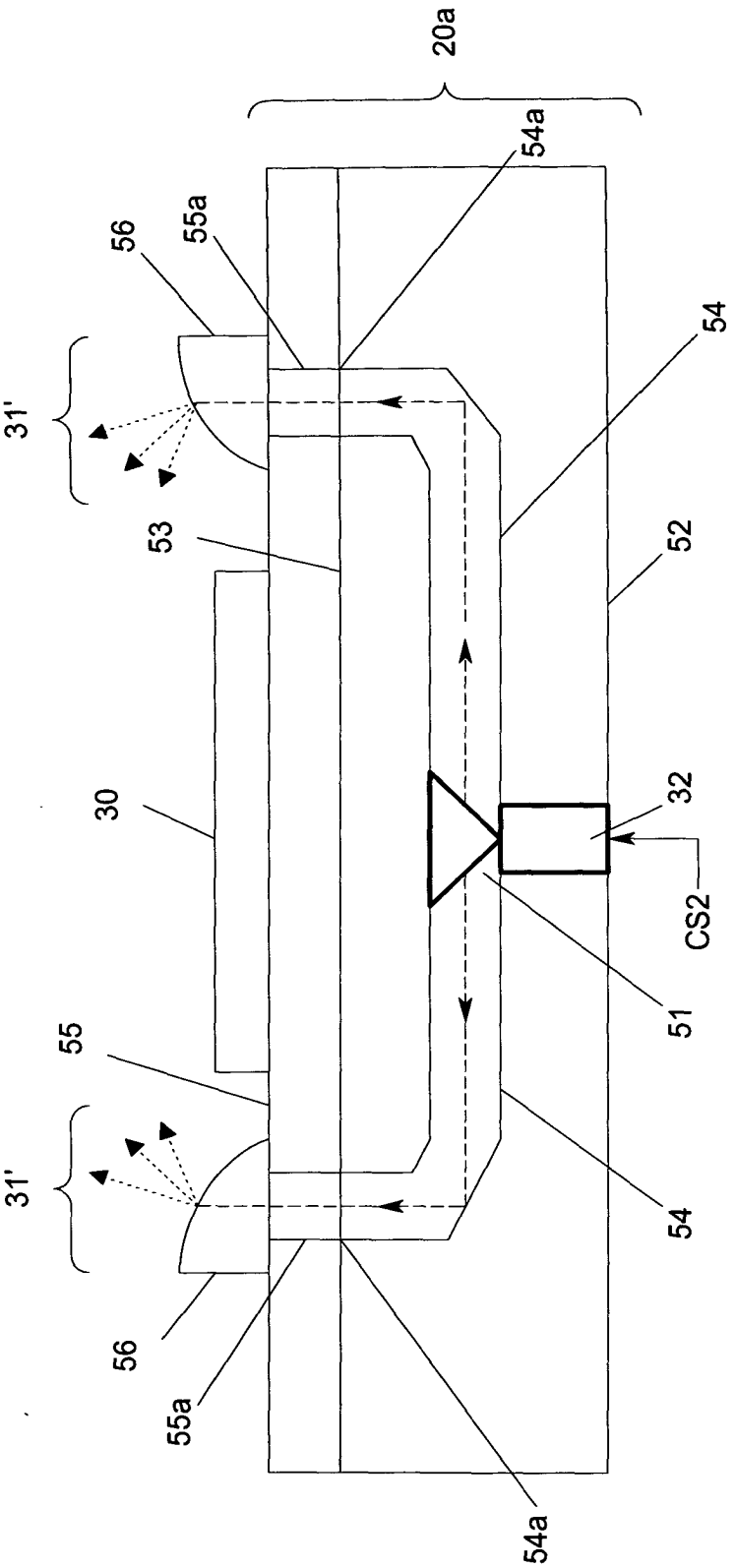


FIG. 8A

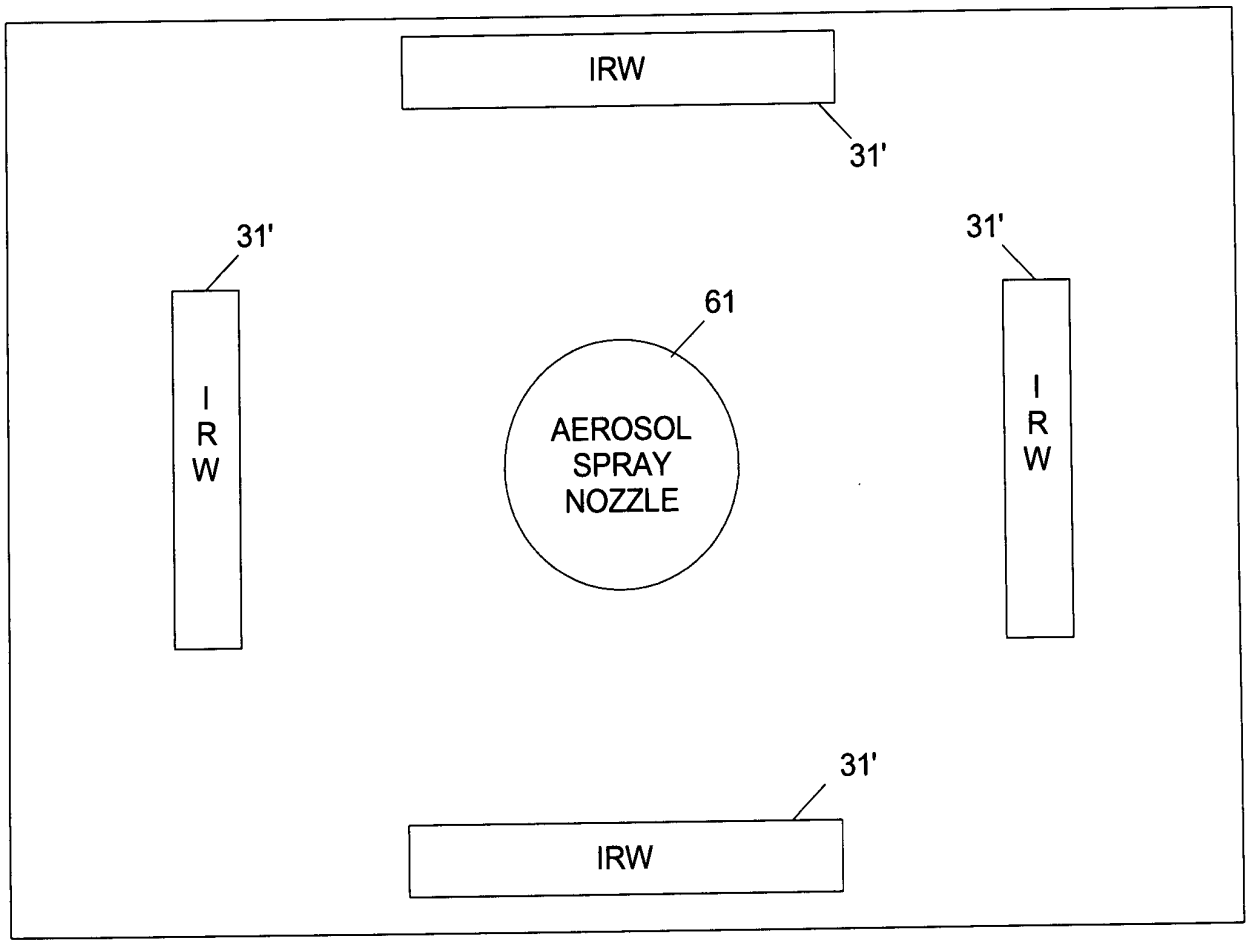
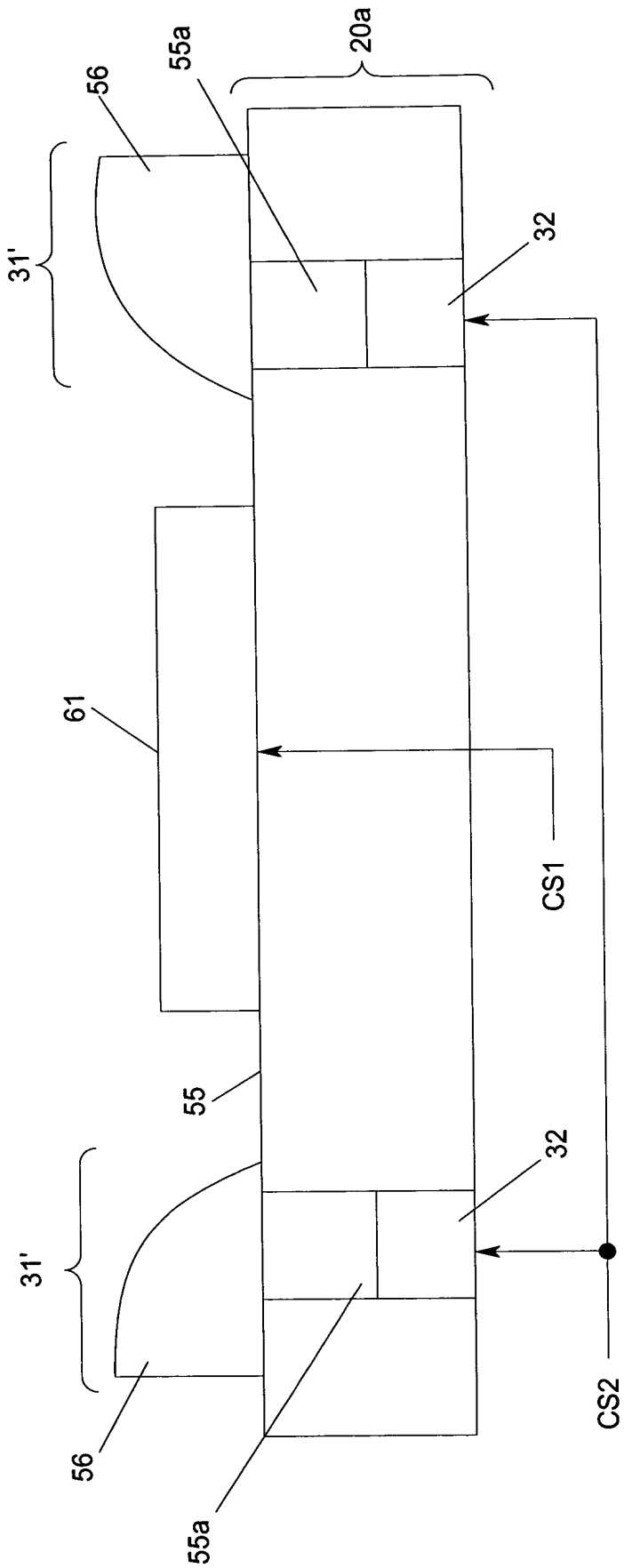


FIG. 8B



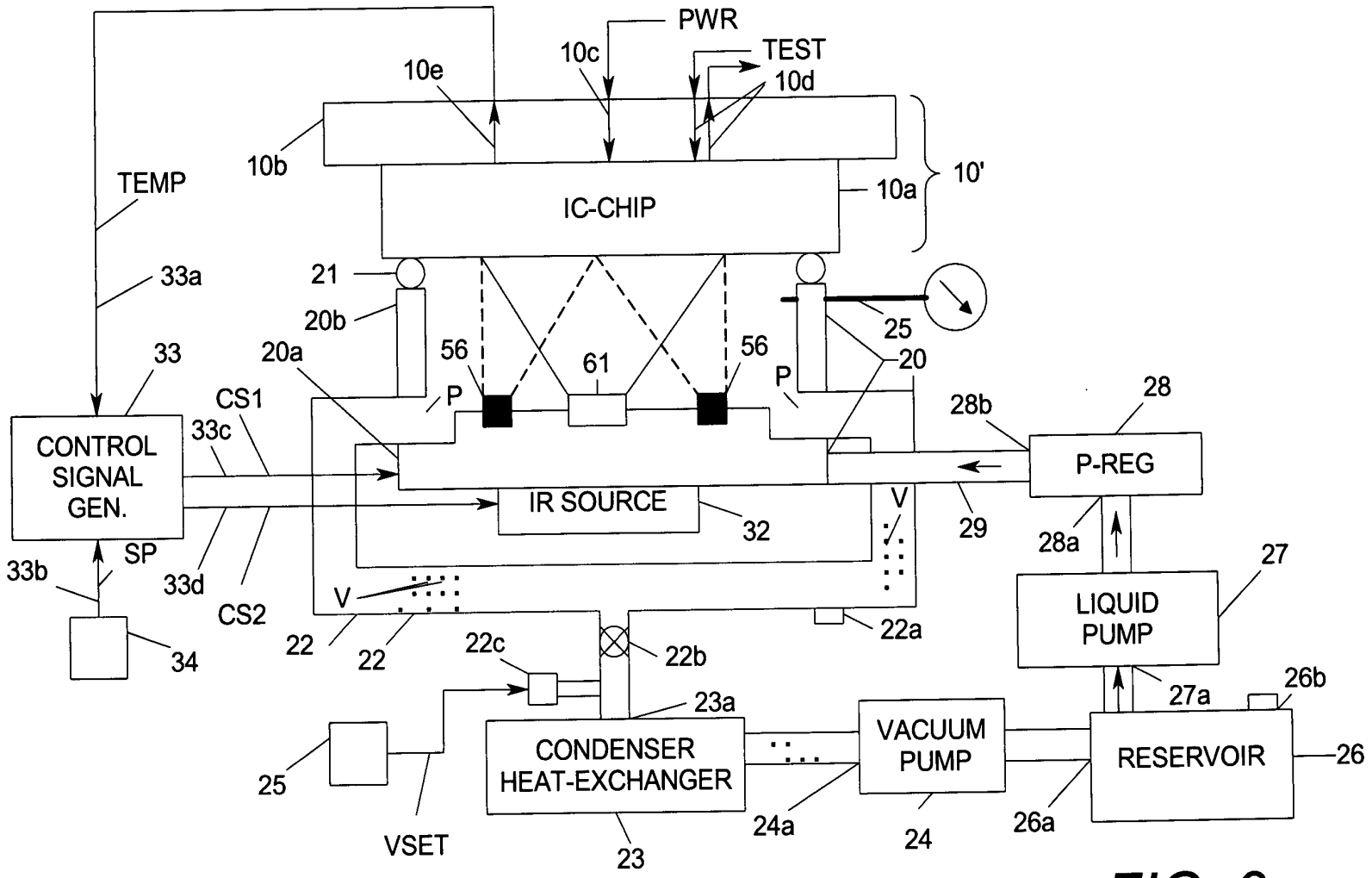

PWR
TEST
10c
10d
10e
10b
10'
10a
IC-CHIP
TEMP
33a
21
20b
20a
56
61
56
25
20
P
P
28
28b
P-REG
33
CS1
33c
CONTROL
SIGNAL
GEN.
IR SOURCE
32
V
29
28a
27
LIQUID
PUMP
SP
33b
33d
CS2
V
22
22
22c
22b
22a
27a
26b
34
23a
25
CONDENSER
HEAT-EXCHANGER
VACUUM
PUMP
RESERVOIR
26
VSET
24a
24
26a
23

FIG. 9